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Sonzini

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(54) **ELECTROMECHANICAL ACTUATOR AND HOME AUTOMATION INSTALLATION COMPRISING SUCH AN ACTUATOR**

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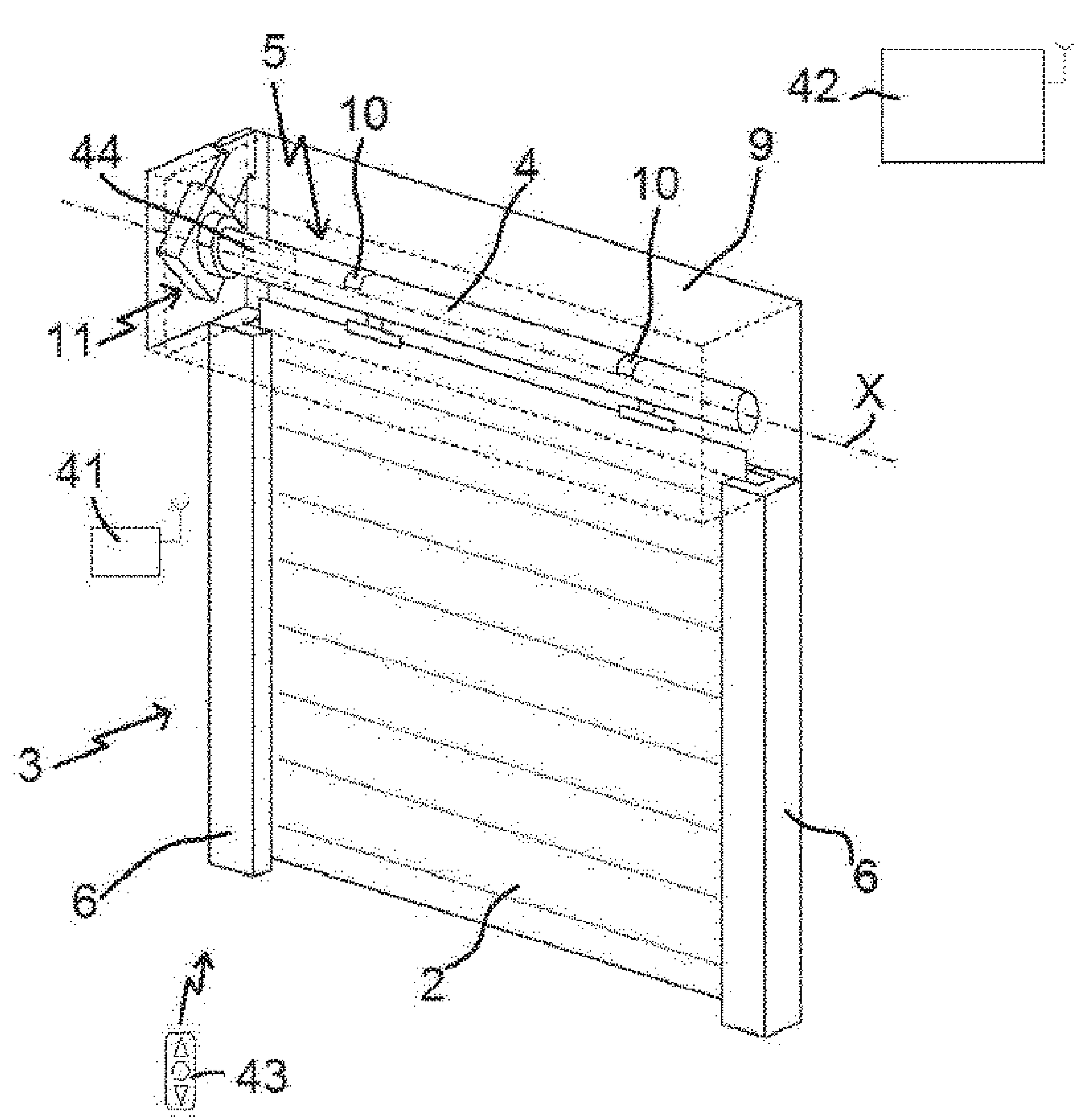
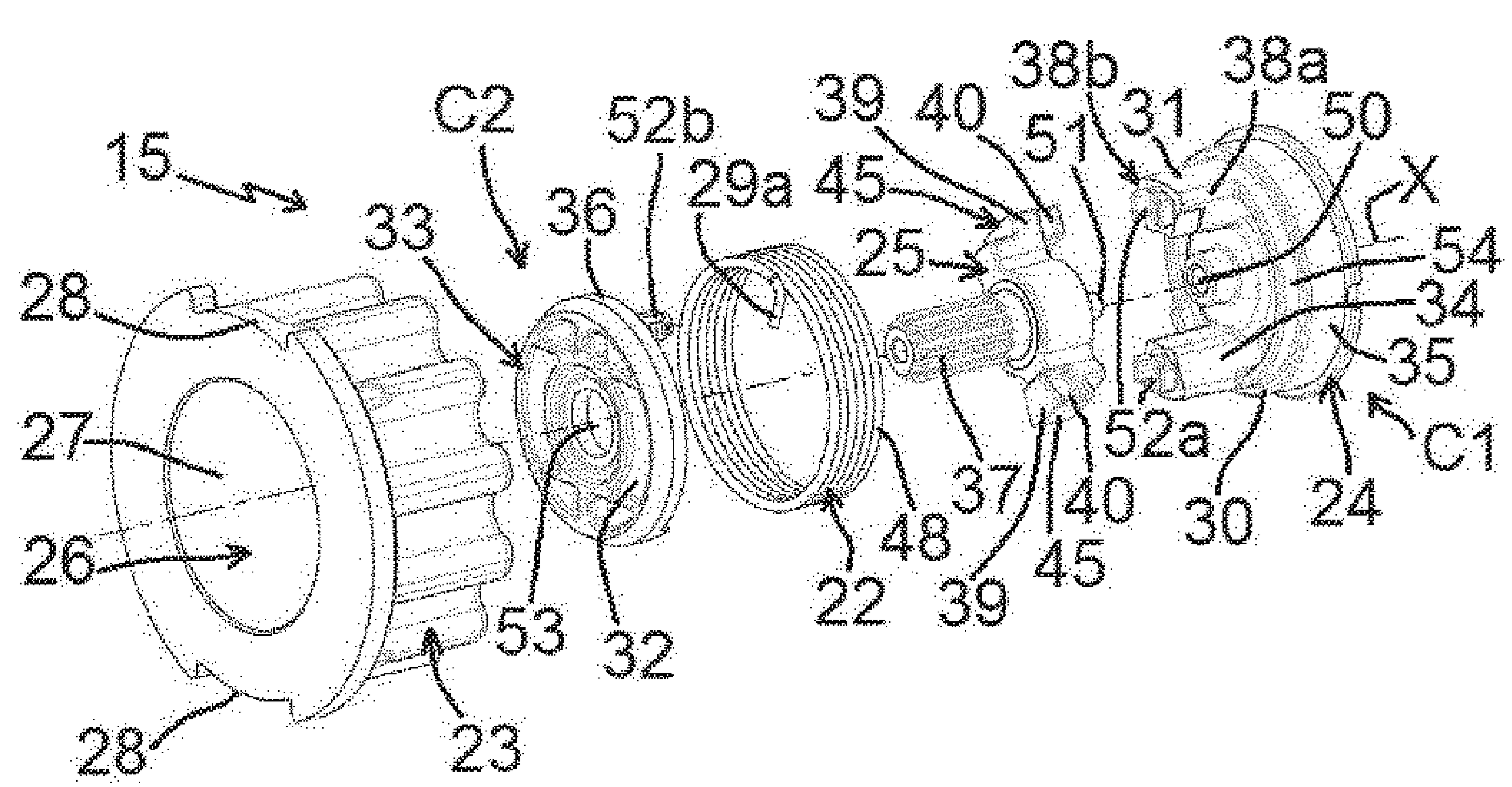
(57) **ABSTRACT**

An electromechanical actuator includes a spring brake with a helical spring, a drum, an input member, an output member and a cap. The drum includes a housing with an inner friction surface configured to cooperate with at least one turn of the spring. The input member includes a driving tooth extending between the input member and the cap. The input member or the cap includes a spacer extending between the input member and the cap. The input member includes a first radial retention element of the spring extending between the tooth and the spacer, along a first side of the brake. Furthermore, the cap includes a second radial retention element of the spring extending between the tooth and the spacer, along a second side of the brake.

20 Claims, 7 Drawing Sheets





(58) **Field of Classification Search**
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See application file for complete search history.

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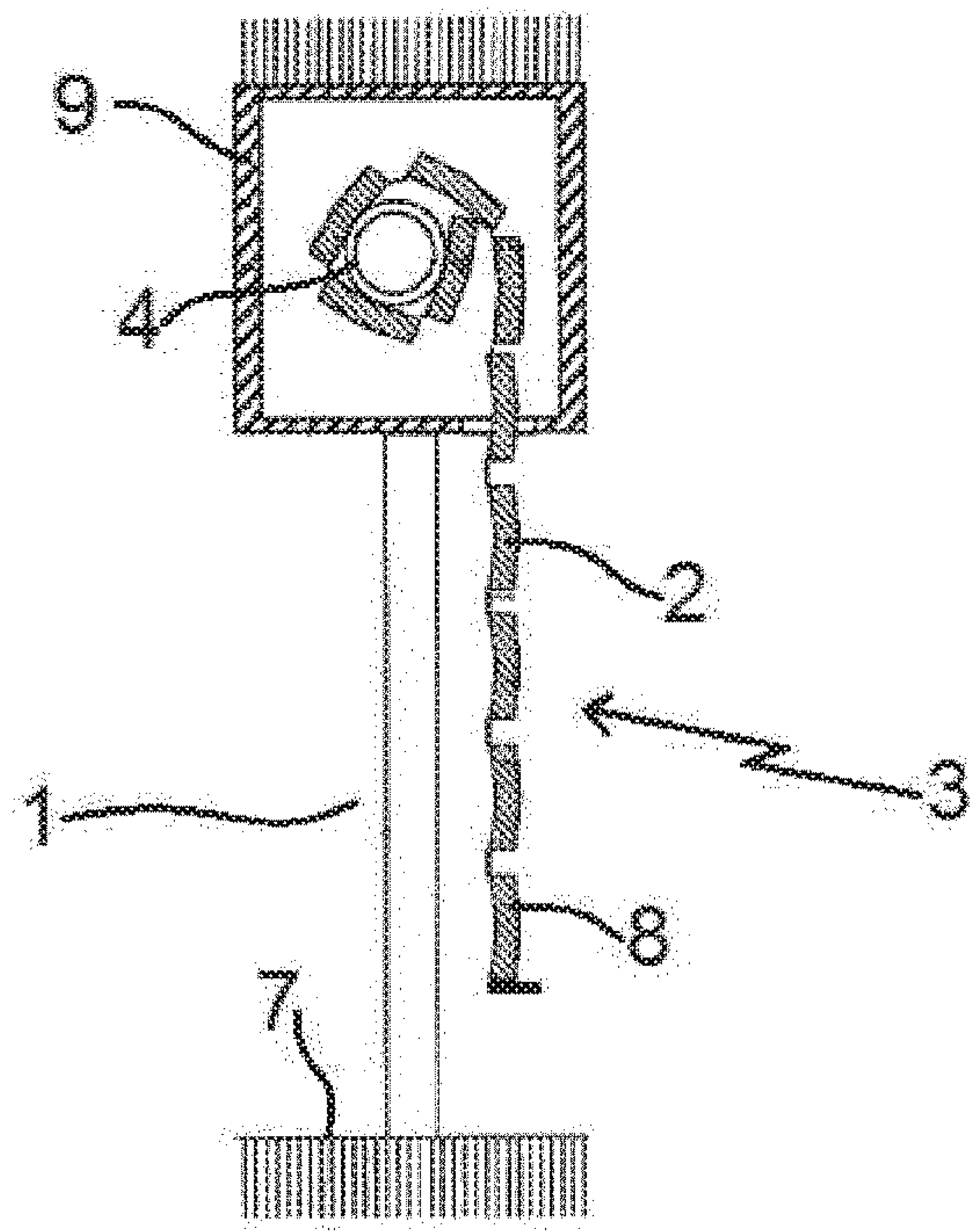


FIG. 1

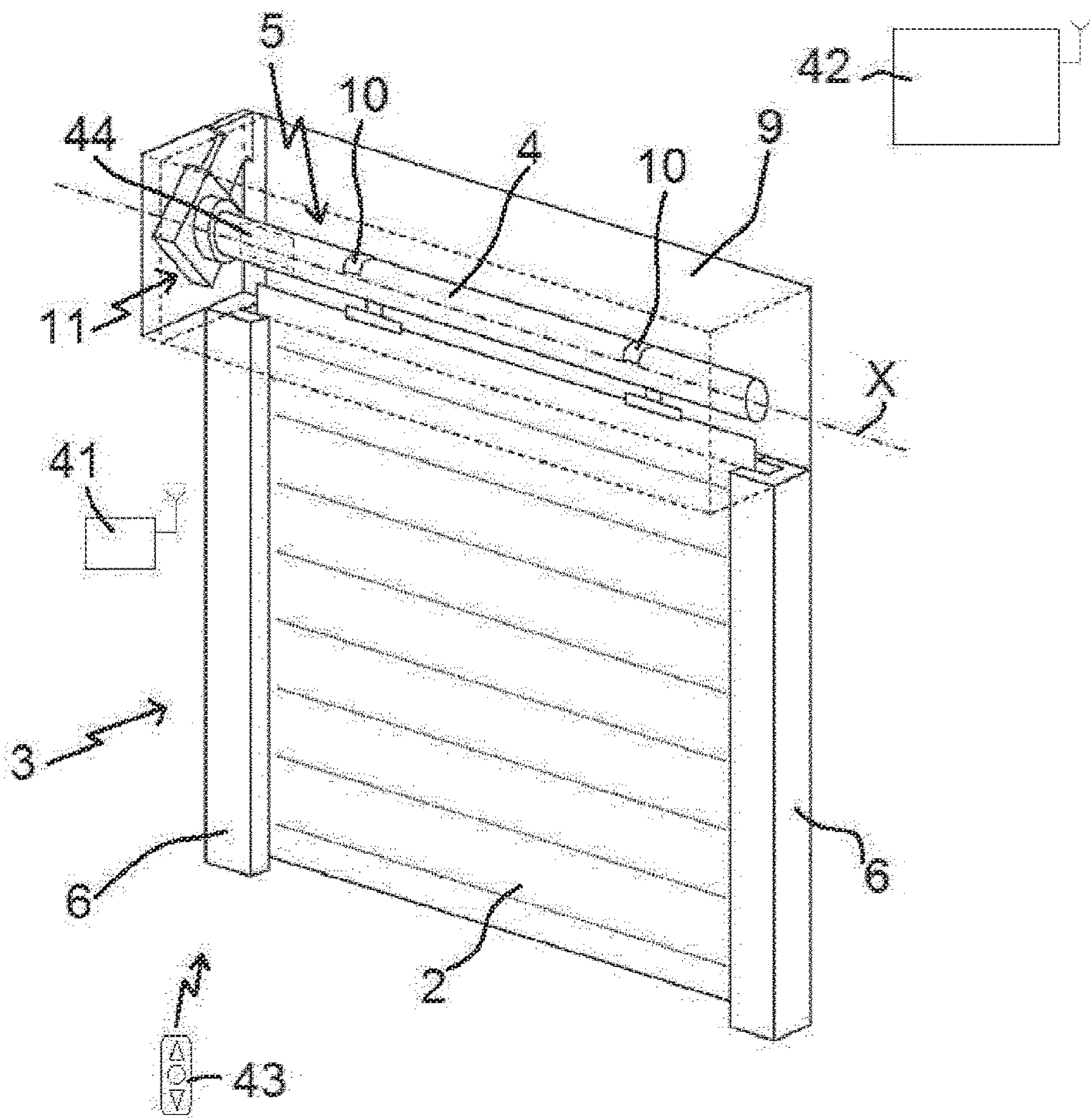


FIG. 2

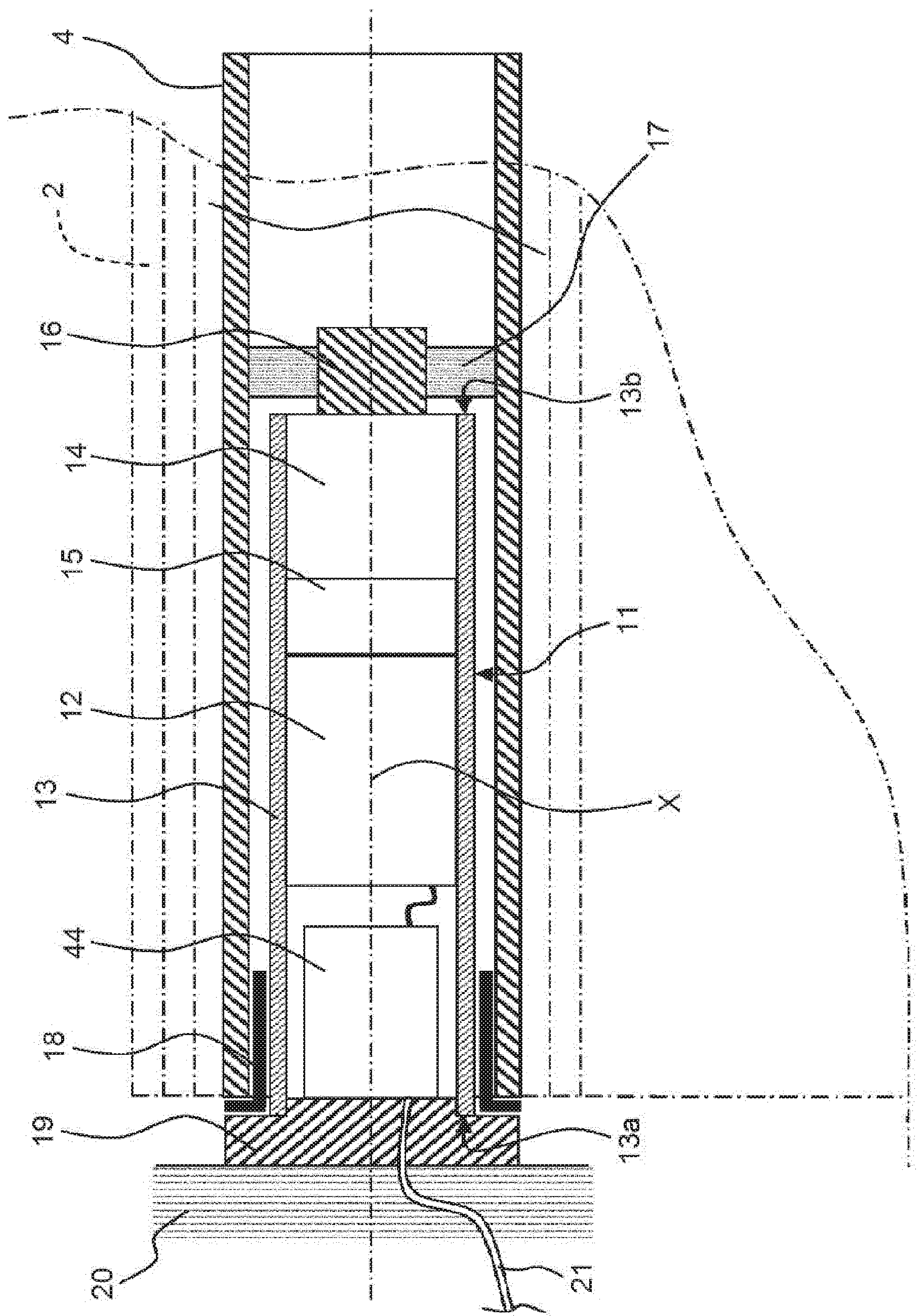
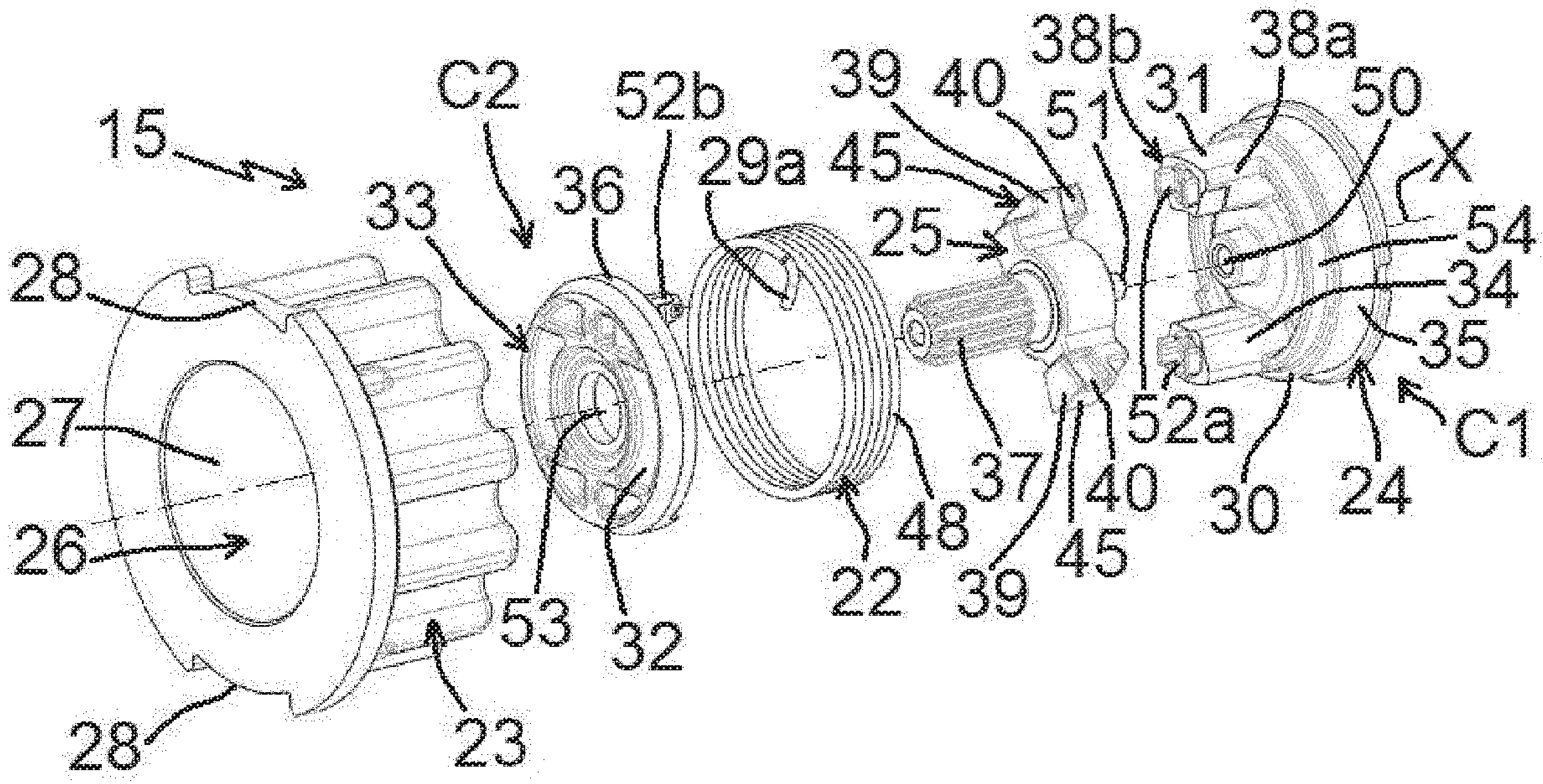


FIG. 3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C1
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FIG. 4

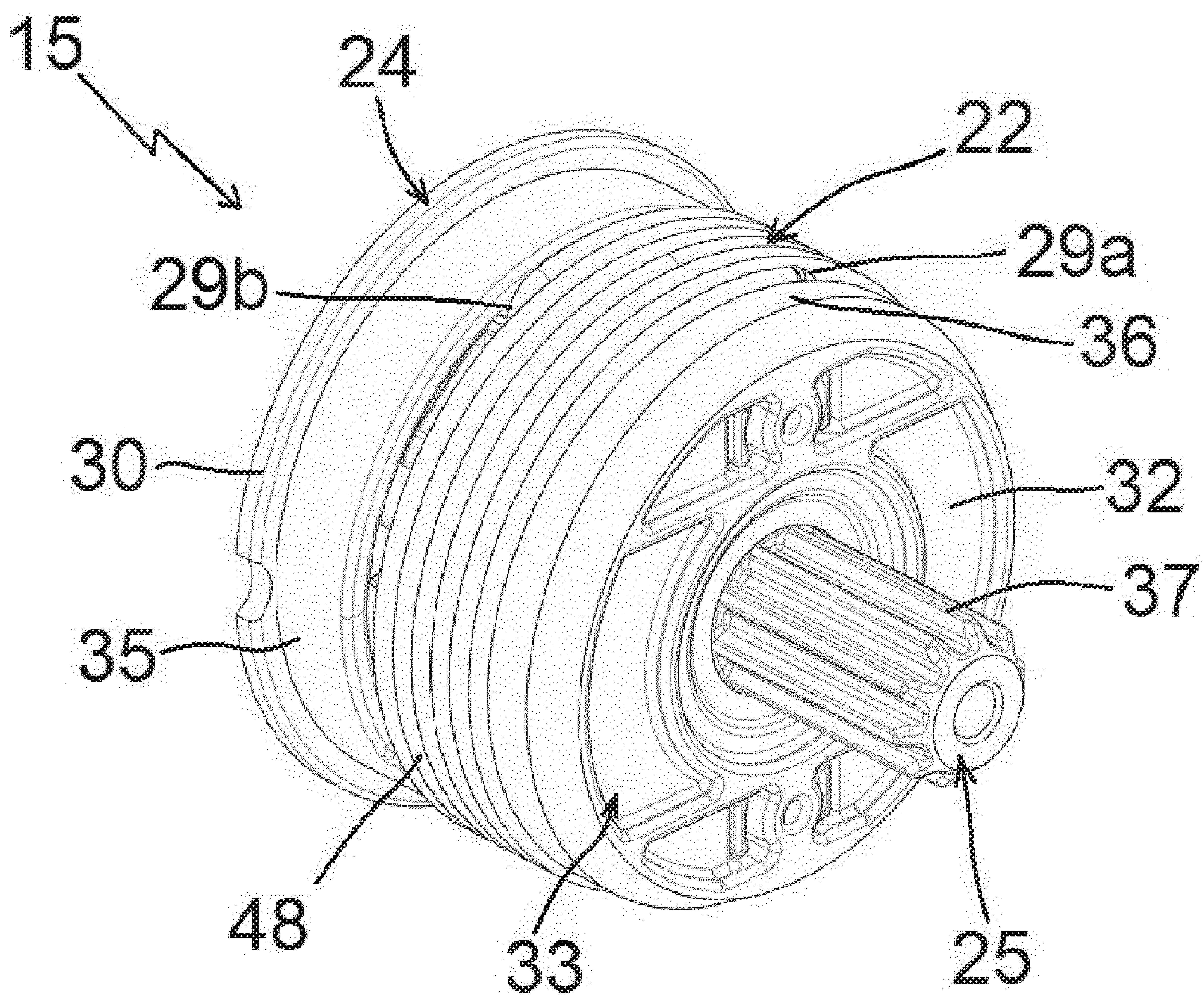
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FIG. 5

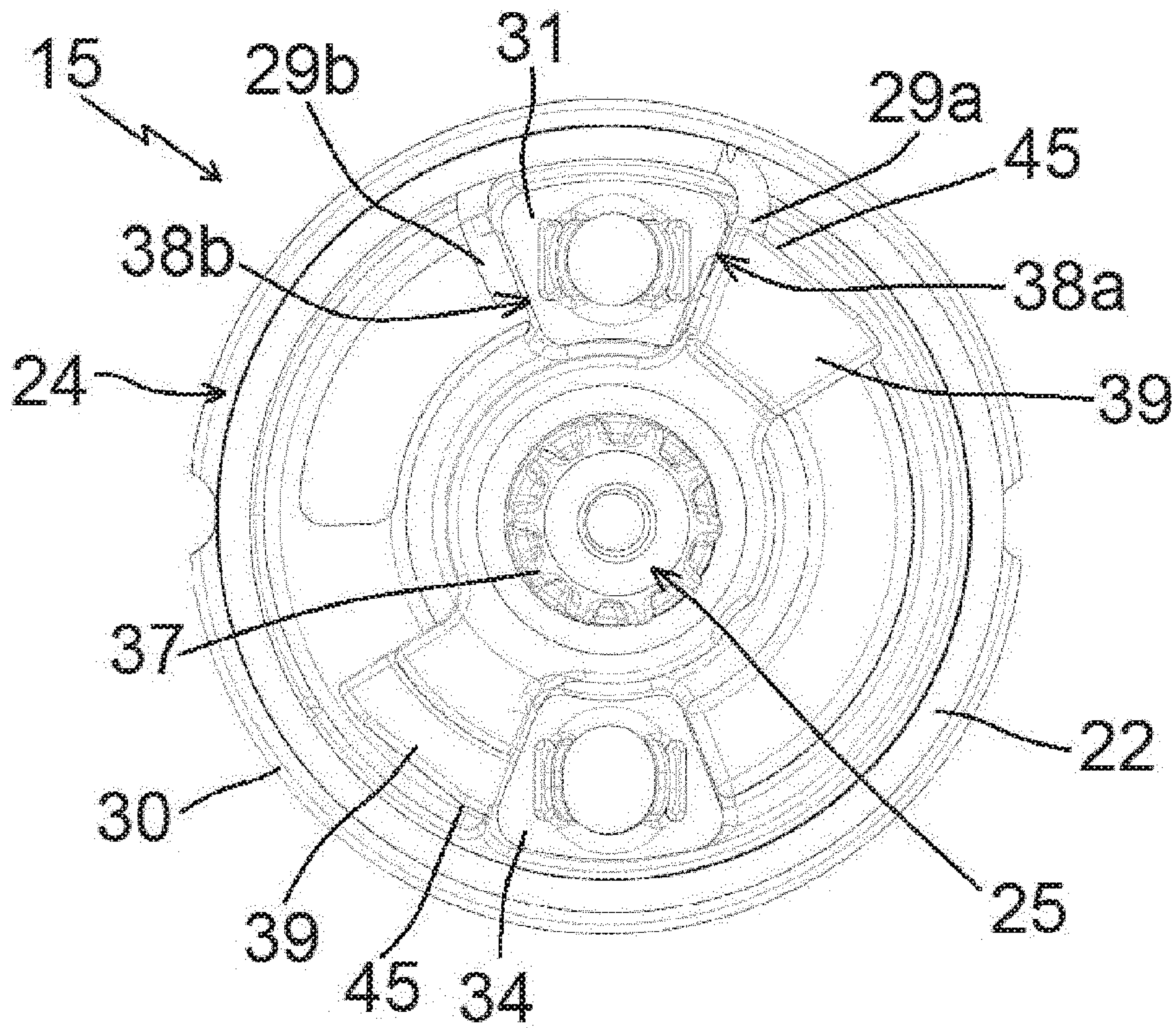
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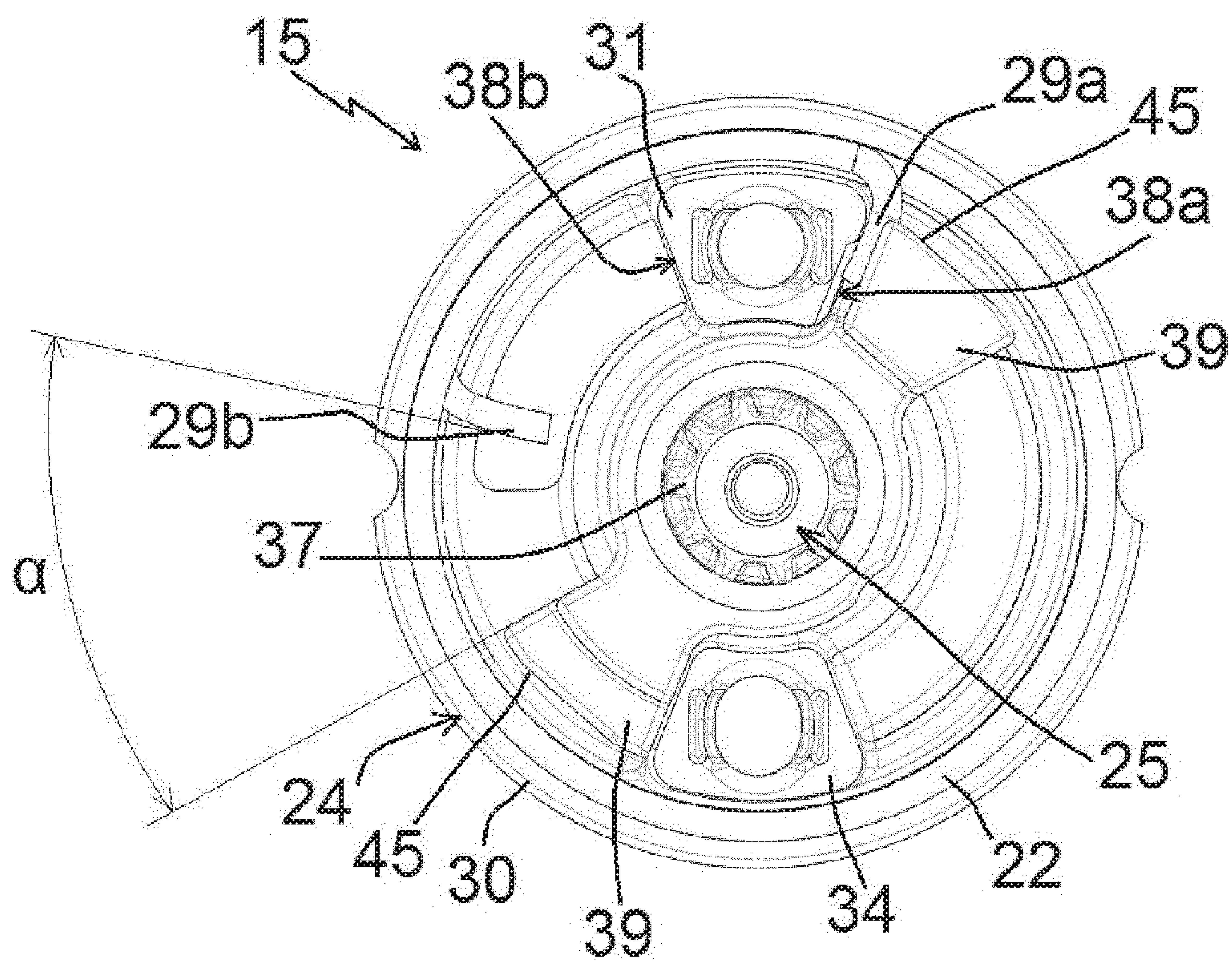
FIG. 6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α
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22

FIG. 7

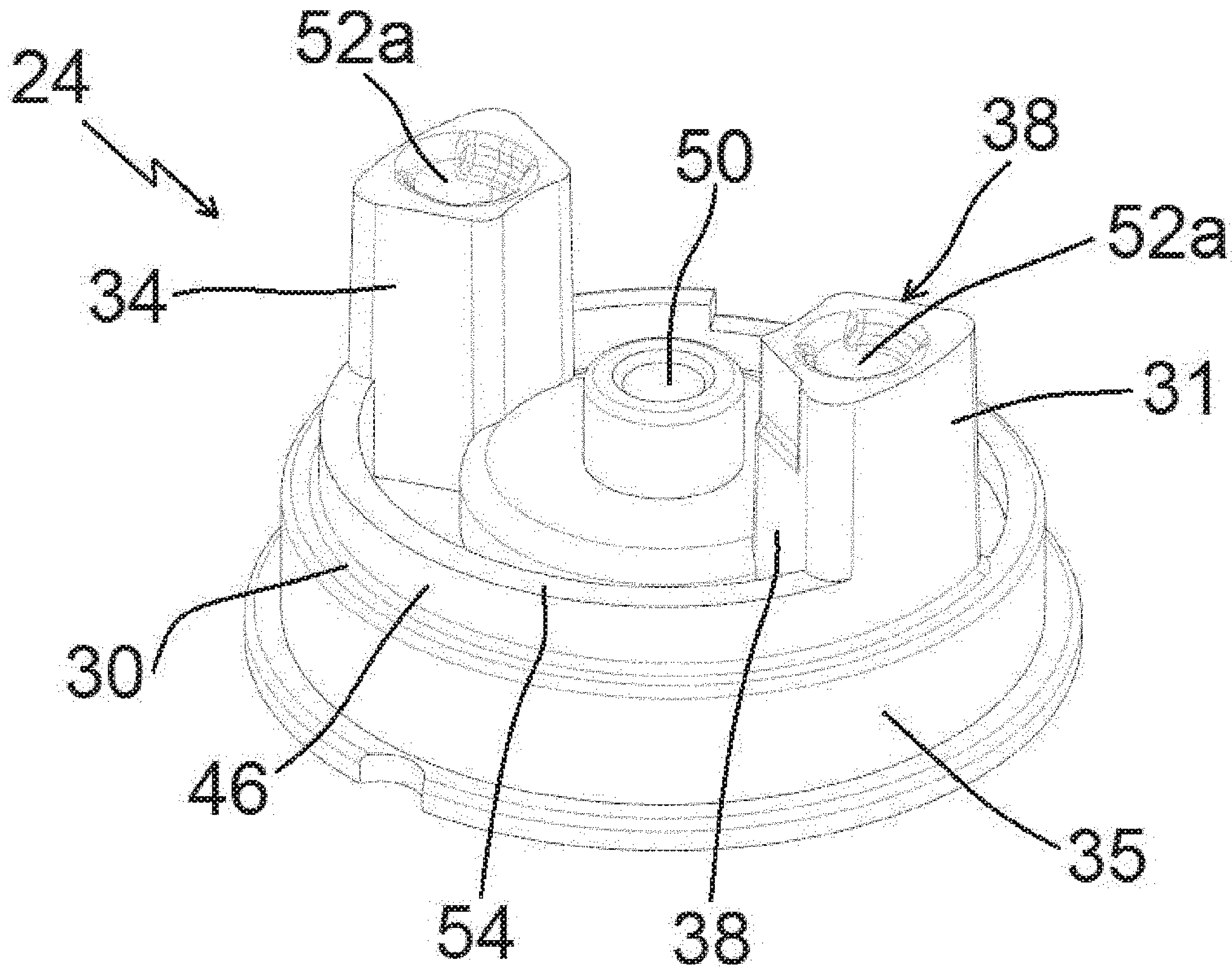


FIG. 8

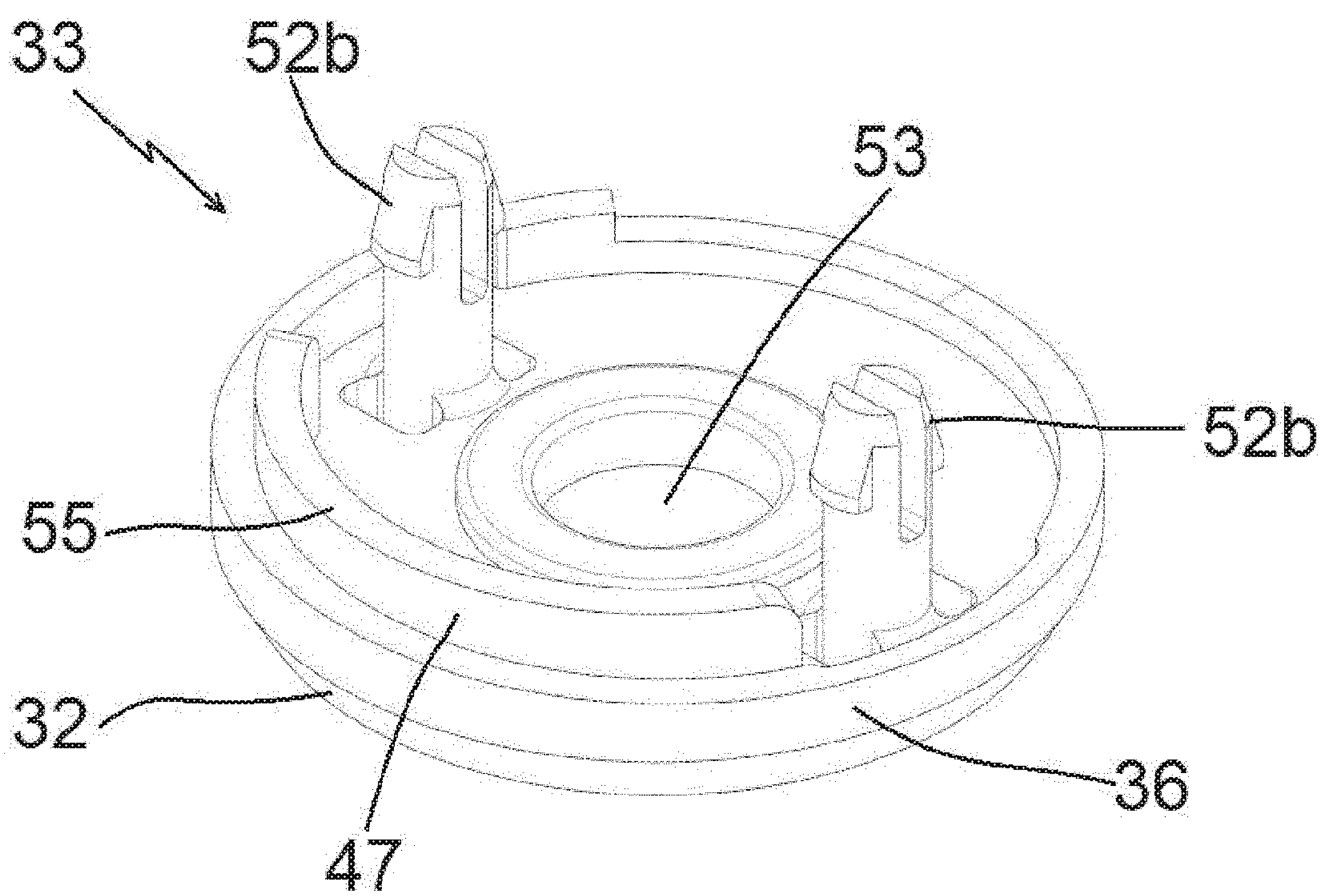
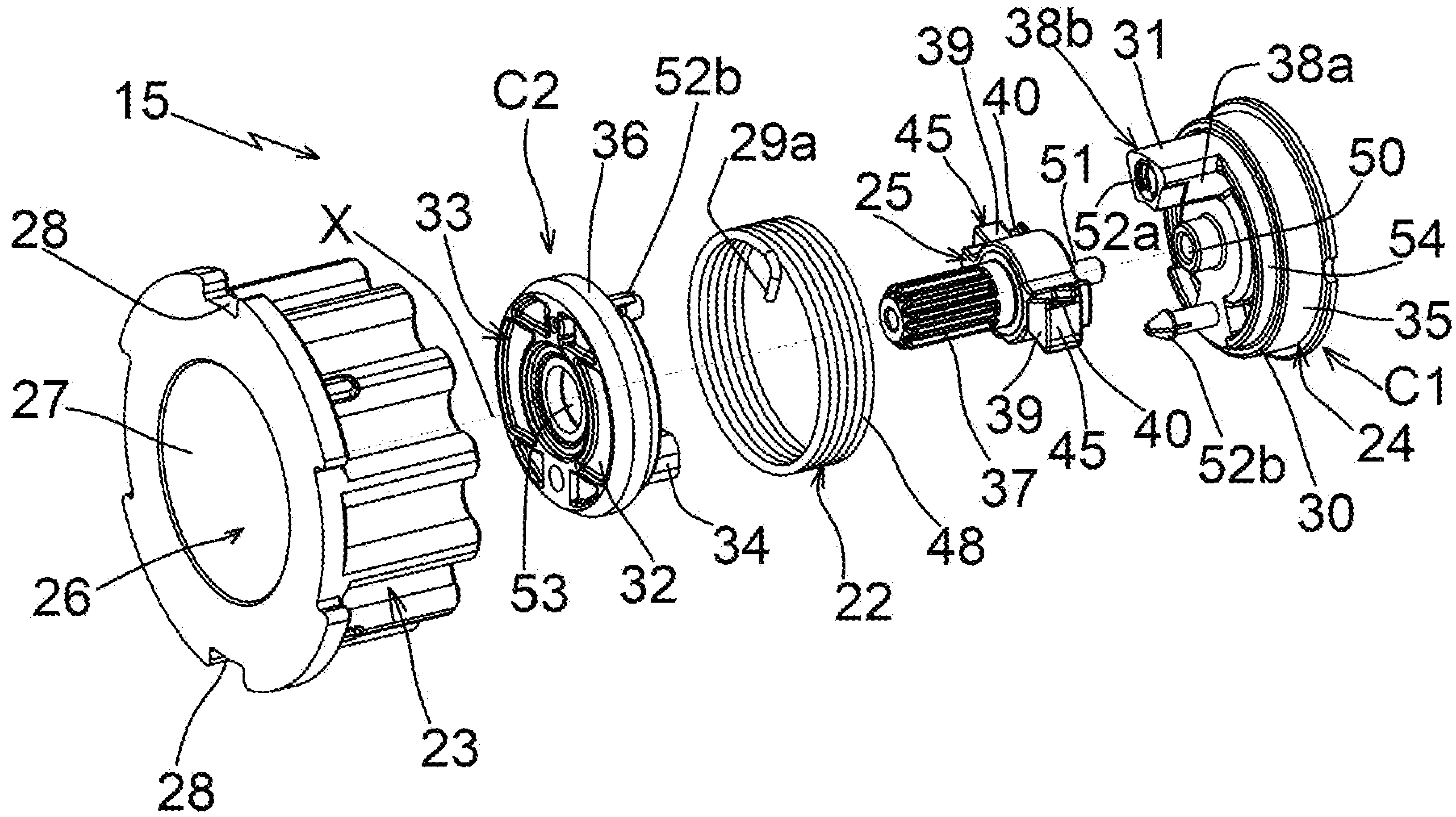


FIG. 9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38b
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38a
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52a
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C1
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52b
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FIG. 10

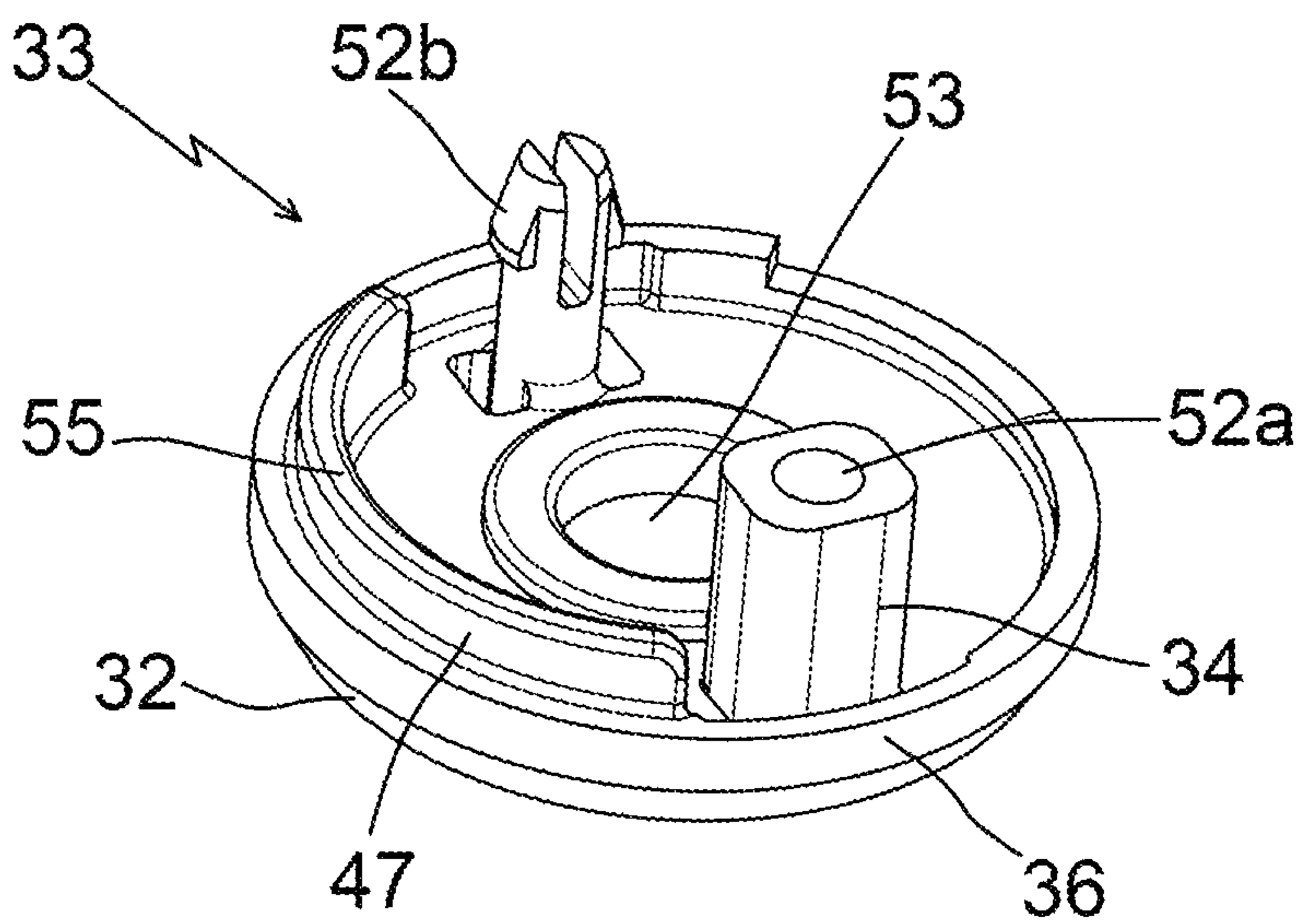

FIG. 11

ELECTROMECHANICAL ACTUATOR AND HOME AUTOMATION INSTALLATION COMPRISING SUCH AN ACTUATOR

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an electromechanical actuator. The electromechanical actuator comprises a spring brake. This type of spring brake is more particularly suitable for a so-called tubular electromechanical actuator.

The present invention also relates to a home automation installation for closing or sun protection comprising a screen able to be wound on a winding tube rotated by one such electromechanical actuator.

In general, the present invention relates to the field of concealing devices comprising a motorized driving device setting a screen in motion, between at least one first position and at least one second position.

Description of the Related Art

A motorized driving device comprises an electromechanical actuator for a movable element for closing, concealing or sun protection such as a shutter, door, gate, blind or any other equivalent material, hereinafter referred to as a screen.

Document FR 2,995,001 A1 is already known, which describes an electromechanical actuator for a closure or sun protection home automation installation. The electromechanical actuator comprises an electric motor, a reduction gear and a spring brake. The spring brake comprises a helical spring, a drum, an input member, an output member and a cap. Each end of the helical spring forms a tab extending radially relative to an axis of rotation of the spring brake. The drum comprises a cylindrical housing. Furthermore, an inner friction surface of the housing of the drum is configured to cooperate with at least one turn of the helical spring. In this way, at least one turn of the helical spring is radially stressed by the housing of the drum.

The input member comprises a driving tooth. The driving tooth extends between the input member and the cap, in an assembled configuration of the spring brake. Furthermore, the input member or the cap comprises a spacer. The spacer extends between the input member and the cap, in the assembled configuration of the spring brake.

The output member comprises two lugs.

The input member is rotated by the electric motor. The driving tooth of the input member is configured to cooperate with one of the tabs of the helical spring, so as to rotate the helical spring around the axis of rotation of the spring brake in a first direction of rotation. Such a movement releases the spring brake. The frictional force between the turns of the helical spring and the inner surface of the housing of the drum is decreased during rotational driving of the helical spring in the first direction of rotation. In other words, this movement tends to decrease the diameter of the outer enclosure of the helical spring and therefore to decrease the radial stress between the helical spring and the inner surface of the housing of the drum.

One of the lugs of the output member is configured to cooperate with one of the tabs of the helical spring, so as to rotate the helical spring around the axis of rotation of the spring brake in a second direction of rotation, the second direction of rotation being opposite the first direction of rotation. Such a movement activates the spring brake. The frictional force between the turns of the helical spring and the inner surface of the housing of the drum is increased during the rotational driving of the helical spring in the second direction of rotation. In other words, this movement tends to increase the diameter of the outer enclosure of the helical spring and therefore to increase the radial stress between the helical spring and the inner surface of the housing of the drum.

However, this electromechanical actuator has the drawback of generating operating noises and manufacturing defects related to a misalignment of the helical spring relative to the input member, the output member and the cap. This misalignment generates unwanted friction between the elements of the spring brake.

As a result, in order to limit the unwanted friction, sizing adaptations of the elements of the spring brake are necessary, in particular to reduce the dimensions of the driving tooth of the input member, the spacer and the lugs of the output member, which may cause risks in terms of the quality of the spring brake and therefore the electromechanical actuator.

Furthermore, during the manufacturing of this electromechanical actuator, the helical spring lacks radial retention relative to the input member, the output member and the cap.

As a result, during assembling of the assembly formed by the input member, the helical spring, the output member and the cap inside the drum and, more particularly, during a winding operation of the helical spring, the helical spring is positioned on a slant inside the housing of the drum.

Furthermore, during assembling of the assembly formed by the input member, the helical spring, the output member and the cap inside the housing of the drum, the helical spring rubs on the inner friction surface of the housing of the drum and at least partially withdraws a lubricant deposited on this inner friction surface and on the helical spring.

SUMMARY OF THE INVENTION

The present invention aims to resolve the aforementioned drawbacks and to propose an electromechanical actuator for a closure or sun protection home automation installation comprising a spring brake, as well as a home automation installation for closing or sun protection comprising such an electromechanical actuator, making it possible to guarantee the radial retention of a helical spring with respect to an input member, an output member and a cap, during the manufacturing of the spring brake and during the operation of the spring brake, as well as to reduce the operating noises of the spring brake, during the rotational driving of an input member and/or an output member inside a housing of a drum.

To that end, according to a first aspect, the present invention relates to an electromechanical actuator for a closure or sun protection home automation installation,

the electromechanical actuator comprising at least:

an electric motor,

a reduction gear, and

a spring brake,

the spring brake comprising at least:

a helical spring,

a drum, the drum comprising a housing, the housing of the drum comprising an inner friction surface configured to cooperate with at least one turn of the helical spring,

an input member,

an output member, and

a cap,

the input member comprising a driving tooth, the driving tooth extending between the input member and the cap, in an assembled configuration of the spring brake, and

the input member or the cap comprising a spacer, the spacer extending between the input member and the cap, in the assembled configuration of the spring brake.

According to the invention, the input member comprises a first element for radial retention of the helical spring extending between the driving tooth and the spacer, along a first side of the spring brake, in the assembled configuration of the spring brake. Furthermore, the cap comprises a second radial retention element of the helical spring extending between the driving tooth and the spacer, along a second side of the spring brake, in the assembled configuration of the spring brake, the second side of the spring brake being opposite the first side of the spring brake, relative to an axis of rotation of the spring brake.

Thus, the first and second radial retention elements of the input member and the cap respectively extending between the driving tooth and the spacer make it possible to guarantee the radial retention of the helical spring with respect to the input member, the output member and the cap, during the manufacturing of the spring brake and during the operation of the spring brake, as well as to reduce the operating noises of the spring brake, during the rotational driving of the input member and/or the output member inside the housing of the drum.

In this way, the first and second radial retention elements of the input member and the cap respectively extending between the driving tooth and the spacer make it possible to avoid manufacturing defects related to a misalignment of the helical spring with respect to the input member, the output member and the cap.

As a result, the first and second radial retention elements of the input member and the cap respectively extending between the driving tooth and the spacer make it possible to guarantee the positioning of the helical spring inside the housing of the drum, during the assembly of the spring brake and, more specifically, during a winding operation of the helical spring.

Furthermore, during the assembly of the spring brake, the first and second radial retention elements of the input member and the cap respectively extending between the driving tooth and the spacer make it possible to limit rubbing of the helical spring on the inner friction surface of the housing of the drum and therefore to avoid the withdrawal of at least part of a lubricant deposited on this inner friction surface and on the helical spring.

According to one advantageous feature of the invention, the first and second radial retention elements respectively comprise a rib extending partially between the input member and the cap, along the direction of the rotation axis, in the assembled configuration of the spring brake.

According to another advantageous feature of the invention, an outer surface of the first radial retention element and an outer surface of the second radial retention element are configured to cooperate with at least one turn of the helical spring.

According to another advantageous feature of the invention, the helical spring is formed from a wire. A first end of the helical spring forms a first tab. A second end of the helical spring forms a second tab. Furthermore, each of the first and second tabs extends radially relative to the rotation axis and toward the inside of the helical spring.

According to another advantageous feature of the invention, in the assembled configuration of the spring brake, the first tab of the helical spring is configured to cooperate with a first surface of the driving tooth of the input member and the second tab of the helical spring is configured to cooperate with a second surface of the driving tooth of the input member, the second surface of the driving tooth being opposite the first surface of the driving tooth.

According to another advantageous feature of the invention, in the assembled configuration of the spring brake, the first tab of the helical spring is positioned between the first surface of the driving tooth of the input member and the spacer. Furthermore, the second tab of the helical spring is positioned between the second surface of the driving tooth of the input member and the spacer.

According to another advantageous feature of the invention, the input member comprises a first plate. The cap comprises a second plate. Furthermore, in the assembled configuration of the spring brake, the first tab of the helical spring extends along the second plate of the cap and the second tab of the helical spring extends along the first plate of the input member.

According to another advantageous feature of the invention, the input member and the cap are kept secured in rotation about the axis of rotation, in the assembled configuration of the spring brake.

According to another advantageous feature of the invention, the input member and the cap are fastened to one another using fastening elements. Furthermore, the fastening elements of the input member and the cap are fastening elements by resilient snapping positioned at the driving tooth and the spacer.

According to a second aspect, the invention relates to a home automation installation for closing or providing sun protection that comprises a screen able to be wound on a winding tube rotated by an electromechanical actuator according to the invention.

This home automation installation has features and advantages similar to those previously described relative to the electromechanical actuator according to the invention, as described above.

Other particularities and advantages of the invention will also appear in the description below.

BRIEF DESCRIPTION OF THE DRAWINGS

In the appended drawings, provided as non-limiting examples:

FIG. **1** is a cross-sectional schematic view of a home automation installation according to one embodiment of the invention;

FIG. **2** is a perspective schematic view of the home automation installation illustrated in FIG. **1**;

FIG. **3** is a partial sectional schematic view of the home automation installation illustrated in FIG. **2**, at an electromechanical actuator;

FIG. **4** is an exploded and perspective schematic view of a spring brake of the electromechanical actuator illustrated in FIG. **3**;

FIG. **5** is a perspective schematic view of the spring brake illustrated in FIG. **4**, where a drum of the spring the brake has been removed;

FIG. **6** is a first sectional schematic view of the spring brake illustrated in FIGS. **4** and **5**, before the introduction of an input member, an output member and a helical spring inside the drum;

FIG. **7** is a second sectional schematic view of the spring brake illustrated in FIGS. **4** to **6**, after the introduction of the input member, the output member and the helical spring inside the drum, where the drum of the spring brake has been removed;

FIG. **8** is a perspective schematic view of the input member of the spring brake illustrated in FIGS. **4** to **7**; and

FIG. **9** is a perspective schematic view of a cap of the spring brake illustrated in FIGS. **4** to **7**.

FIGS. **10** and **11** show a particular embodiment where the cap comprises a spacer.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In reference to FIGS. **1** and **2**, we first describe a home automation installation according to the invention and installed in a building comprising an opening **1**, window or door, equipped with a screen **2** belonging to a concealing device **3**, in particular a motorized rolling shutter.

The concealing device **3** can be a rolling shutter, as illustrated in FIGS. **1** and **2**, a canvas blind or a blind with adjustable slats, or a rolling gate. The present invention applies to all types of concealing devices.

A rolling shutter according to one embodiment of the invention is described in reference to FIGS. **1** and **2**.

The screen **2** of the concealing device **3** is wound on a winding tube **4** driven by a motorized driving device **5** and movable between a wound position, in particular an upper position, and an unwound position, in particular a lower position.

The moving screen **2** of the concealing device **3** is a closing, concealing and/or sun protection screen, winding on the winding tube **4**, the inner diameter of which is generally substantially greater than the outer diameter of an electromechanical actuator **11**, such that the electromechanical actuator **11** can be inserted into the winding tube **4**, during the assembly of the concealing device **3**.

The motorized driving device **5** comprises the electromechanical actuator **11**, in particular of the tubular type, making it possible to set the winding tube **4** in rotation, so as to unwind or wind the screen **2** of the concealing device **3**.

The concealing device **3** comprises the winding tube **4** for winding the screen **2**. In the mounted state, the electromechanical actuator **11** is inserted into the winding tube **4**.

In a known manner, the rolling shutter, which forms the concealing device **3**, comprises an apron comprising horizontal slats articulated on one another, forming the screen **2** of the rolling shutter **3**, and guided by two lateral guideways **6**. These slats are joined, when the apron **2** of the rolling shutter **3** reaches its unwound lower position.

In the case of a rolling shutter, the wound upper position corresponds to the bearing of a final end slat **8**, which is for example L-shaped, of the apron **2** of the rolling shutter **3** against an edge of a box **9** of the rolling shutter **3** or when the final end slat **8** stops in a programmed upper end-of-travel position. Furthermore, the unwound lower position corresponds to the bearing of the final end slat **8** of the apron **2** of the rolling shutter **3** against a threshold **7** of the opening **1** or the stopping of the final end slat **8** in a programmed lower end-of-travel position.

The first slat of the apron **2** of the rolling shutter **3**, opposite the final end slat **8**, is connected to the winding tube **4** using at least one articulation **10**, in particular a fastener in strip form.

The winding tube **4** is positioned inside the box **9** of the rolling shutter **3**. The apron **2** of the rolling shutter **3** winds and unwinds around the winding tube **4** and is housed at least partially inside the box **9**.

In general, the box **9** is positioned above the opening **1**, or in the upper part of the opening **1**.

The motorized driving device **5** is controlled by a control unit. The control unit may, for example, be a local control unit **41**, where the local control unit **41** can be connected through a wired or wireless connection with a central control unit **42**. The central control unit **42** can drive the local control unit **41**, as well as other similar local control units distributed throughout the building.

The central control unit **42** can be in communication with a weather station located outside the building, in particular including one or more sensors that can be configured, for example, to determine a temperature, a brightness, or a wind speed.

A remote control **43**, which can be a type of local control unit, provided with a control keypad and which comprises selection and display means, further allows a user to intervene on the electromechanical actuator **11**, the local control unit **41** and/or the central control unit **42**.

The motorized driving device **5** is, preferably, configured to carry out the unwinding or winding commands of the screen **2** of the concealing device **3**, which may, in particular, be acquired by the remote control **43**.

The electromechanical actuator **11** belonging to the home automation installation of FIGS. **1** and **2** is now described in more detail and in reference to FIG. **3**.

The electromechanical actuator **11** comprises at least an electric motor **12**, a reduction gear **14** and a spring brake **15**.

The electric motor **12** comprises a rotor and a stator, not shown, positioned coaxially around a rotation axis X, which is also the rotation axis of the winding tube **4** in the assembled configuration of the motorized driving device **5**.

Control means for controlling the electromechanical actuator **11**, making it possible to move the screen **2** of the concealing device **3**, comprise at least an electronic control unit **44**. This electronic control unit **44** is able to operate the electric motor **12** of the electromechanical actuator **11** and, in particular, to allow the supply of electricity for the electric motor **12**.

Thus, the electronic control unit **44**, in particular, controls the electric motor **12**, so as to open or close the screen **2**, as previously described.

The electronic control unit **44** also comprises an order receiving module, in particular for wireless orders sent by an order transmitter, such as the remote control **43** designed to control the electromechanical actuator **11** or one of the local **41** or central **42** control units.

The order receiving module can also allow the reception of orders sent by wired means.

Here, and as illustrated in FIG. **3**, the electronic control unit **44** is positioned inside a casing **13** of the electromechanical actuator **11**.

The control means of the electromechanical actuator **11** comprise hardware and/or software means.

As a non-limiting example, the hardware means may comprise at least one microcontroller.

The electromechanical actuator **11** is supplied with electricity by an electricity grid of the sector, or using a battery, which can, for example, be recharged by a photovoltaic panel. The electromechanical actuator **11** makes it possible to move the screen **2** of the concealing device **3**.

Here, the electromechanical actuator **11** comprises an electrical power cable **21** allowing it to be supplied with electricity from an electricity grid of the sector.

The casing **13** of the electromechanical actuator **11** is, preferably, in cylindrical shape.

In one embodiment, the casing **13** is made from a metal material.

The material of the casing of the electromechanical actuator is in no way limiting and may be different. In particular, it can be a plastic material.

The winding tube **4** is rotated around the rotation axis X and the casing **13** of the electromechanical actuator **11** supported by two pivot links. The first pivot link is produced at a first end of the winding tube **4** using a crown **18** inserted around and at an end **13***a* of the casing **13** of the electromechanical actuator **11**. The crown **18** thus makes it possible to produce a bearing. The second pivot link, not shown in FIG. **3**, is produced at a second end of the winding tube **4**.

The electromechanical actuator **11** comprises a torque support **19**. The torque support **19** protrudes at one end **13***a* of the casing **13** of the electromechanical actuator **11**, in particular the end **13***a* of the casing **13** receiving the crown **18**. The torque support **19** of the electromechanical actuator **11** thus makes it possible to fasten the electromechanical actuator **11** on a housing **20**, in particular a flange of the box **9**.

Furthermore, the torque support **19** of the electromechanical actuator **11** can make it possible to close off the end **13***a* of the casing **13**.

Furthermore, the torque support **19** of the electromechanical actuator **11** can make it possible to support the electronic control unit **44**. The electronic control unit **44** can be supplied with electricity via the electrical power cable **21** electrically connected to the electricity grid of the sector, or a battery.

The reduction gear **14** comprises at least one reduction stage. Said at least one reduction stage can be a gear train of the epicyclic type.

The type and number of reduction stages of the reduction gear are in no way limiting.

The electromechanical actuator **11** comprises an output shaft **16**. An end of the output shaft **16** protrudes relative to the casing **13** of the electromechanical actuator **11**, in particular relative to an end **13***b* of the casing **13** opposite its end **13***a*.

The output shaft **16** of the electromechanical actuator **11** is configured to rotate a connecting element **17** connected to the winding tube **4**. The connecting element **17** is made in the form of a wheel.

When the electromechanical actuator **11** is operated, the electric motor **12** and the reduction gear **14** rotate the output shaft **16**. Furthermore, the output shaft **16** of the electromechanical actuator **11** rotates the winding tube **4** via the connecting element **17**. Thus, the winding tube **4** rotates the screen **2** of the concealing device **3**, so as to open or close the opening **1**.

The electric motor **12**, the reduction gear **14** and the spring brake **15** are mounted inside the casing **13** of the electromechanical actuator **11**.

In the embodiment illustrated in FIG. **3**, the spring brake **15** is positioned between the electric motor **12** and the reduction gear **14**, that is to say at the output of the electric motor **12**.

In another embodiment, not shown, where the reduction gear **14** comprises a plurality of reduction stages, the spring brake **15** is positioned between two reduction stages of the reduction gear **14**.

In another embodiment, not shown, the spring brake **15** is positioned at the output of the reduction gear **14**.

The electromechanical actuator **11** may also comprise an end-of-travel and/or obstacle detection device, this detection device being able to be mechanical or electronic.

The spring brake **15** of the electromechanical actuator **11**, illustrated in FIG. **3** and according to one embodiment of the invention, is now described in reference to FIGS. **4** to **9**.

The spring brake **15** comprises at least one helical spring **22**, a drum **23**, an input member **24**, an output member **25** and a cap **33**.

Advantageously, the drum **23** is kept in position in the casing **13** of the electromechanical actuator **11**, in particular using clearances **28** arranged on the outer periphery of the drum **23** and configured to cooperate with tongues, not shown, of an enclosure of the reduction gear **14**.

Furthermore, the enclosure of the reduction gear **14** is kept in position in the casing **13** of the electromechanical actuator **11**.

The drum **23** comprises a housing **26**.

Here, the housing **26** of the drum **23** is in cylindrical shape. Furthermore, the housing **26** of the drum **23** is a through housing.

Advantageously, the helical spring **22**, the input member **24**, the output member **25** and the cap **33** are positioned inside the housing **26** of the drum **23**, in an assembled configuration of the spring brake **15**.

Here, the output member **25** is positioned opposite the input member **24**.

Advantageously, the helical spring **22** comprises a plurality of turns. The turns of the helical spring **22** are centered on an axis combined with the rotation axis X, when the spring brake **15** is assembled, then mounted in the electromechanical actuator **11**.

Likewise, the input member **24** and the output member **25** are centered on an axis combined with the axis of rotation X, when the spring brake **15** is assembled, then mounted in the electromechanical actuator **11**.

The axis of each of the members **22**, **23**, **24**, **25**, **33** of the spring brake **15** is not shown in FIGS. **4** to **9**, so as to simplify the reading thereof.

The housing **26** of the drum **23** comprises an inner friction surface **27** configured to cooperate with at least one turn of the helical spring **22**.

Thus, at least one turn of the helical spring **22** is radially stressed by the housing **26** of the drum **23**.

Here, the helical spring **22** is mounted tightly inside the housing **26** of the drum **23**, so as to secure the helical spring **22** and the drum **23** by friction, when the helical spring **22** is idle, as illustrated in FIG. **7**.

Advantageously, the helical spring **22** is formed from a wire **48**. A first end of the helical spring **22** forms a first tab **29***a*. A second end of the helical spring **22** forms a second tab **29***b*. Furthermore, each of the first and second tabs **29***a*, **29***b* extends radially relative to the rotation axis X and toward the inside of the helical spring **22**.

Thus, the helical spring **22** includes two tabs **29***a*, **29***b*, only one of which is visible in FIG. **4**.

Here, each tab **29***a*, **29***b* of the helical spring **22** extends radially relative to the axis of rotation X, in the assembled configuration of the spring brake **15**.

In a variant, not shown, each tab **29***a*, **29***b* of the helical spring **22** extends axially relative to the axis of rotation X, in the assembled configuration of the spring brake **15**.

In this exemplary embodiment, the tabs **29***a*, **29***b* of the helical spring **22** extend radially relative to the rotation axis X and toward the inside of the helical spring **22**, in particular from the turns of the helical spring **22** toward the central axis of the helical spring **22**, as illustrated in FIG. **4**.

The input member **24**, in particular a driving tooth **31**, is configured to cooperate with at least one of the tabs **29***a*, **29***b* of the helical spring **22**, so as to rotate the helical spring **22** around the rotation axis X in a first direction of rotation.

Such a movement releases the spring brake **15**.

The friction force between at least one turn of the helical spring **22** and the inner surface **27** of the housing **26** of the drum **23** is decreased during the rotational driving of the helical spring **22** in the first direction of rotation.

In other words, this movement tends to decrease the diameter of the outer enclosure of the helical spring **22** and therefore to decrease the radial stress between the helical spring **22** and the inner surface **27** of the housing **26** of the drum **23**.

Thus, the movement generated by the electric motor **12** can be transmitted from the input member **24** to the output member **25**.

The outer enclosure of the helical spring **22** is defined by the outer generatrixes of the turns of the helical spring **22**.

Advantageously, the output member **25** comprises two lugs **39**, as illustrated in FIGS. **4**, **6** and **7**. The lugs **39** of the output member **25** are configured to be inserted inside the helical spring **22**, in the assembled configuration of the spring brake **15**.

Preferably, each lug **39** of the output member **25** comprise a recess **40**. The recess **40** of each lug **39** of the output member **25** is configured to cooperate with one of the tabs **29***a*, **29***b* of the helical spring **22**.

The output member **25**, in particular one of the lugs **39**, is configured to cooperate with at least one of the tabs **29***a*, **29***b* of the helical spring **22** so as to rotate the helical spring **22** around the rotation axis X in a second direction of rotation. The second direction of rotation is opposite the first direction of rotation.

Such a movement activates the spring brake **15**, that is to say tends to block or slow the rotation of the helical spring **22** inside the housing **26** of the rotating drum **23**.

The friction force between at least one turn of the helical spring **22** and the inner surface **27** of the housing **26** of the drum **23** is increased during the rotational driving of the helical spring **22** in the second direction of rotation.

In other words, this movement tends to increase the diameter of the outer enclosure of the helical spring **22**, in particular by bringing the tabs **29***a*, **29***b* of the helical spring **22** closer together, and therefore to increase the radial stress between the helical spring **22** and the inner surface **27** of the housing **26** of the drum **23**.

Advantageously, the spring brake **15** comprises a lubricant, not shown, arranged between the helical spring **22** and the inner surface **27** of the housing **26** of the drum **23**. The lubricant is, preferably, grease.

Advantageously, the input member **24** is configured to be rotated by the electric motor **12**, in an assembled configuration of the electromechanical actuator **11**.

Here, and as illustrated in FIGS. **4** and **8**, the input member **24** comprises a housing **50**. The housing **50** of the input member **24** is configured to cooperate with a shaft **37** of the output member **25**.

Thus, the shaft **37** of the output member **25** makes it possible to receive and transmit torque coming from the electric motor **12**.

In this exemplary embodiment, the shaft **37** of the output member **25** is configured to cooperate with the reduction gear **14**.

Thus, the shaft **37** of the output member **25** makes it possible to receive and transmit torque coming from the electric motor **12** to the reduction gear **14**, by means of the housing **50** of the input member **24** and the shaft **37** of the output member **25**.

The shaft **37** of the output member **25** is centered relative to the rotation axis X, in the assembled configuration of the electromechanical actuator **11**.

In this exemplary embodiment, the housing **50** of the input member **24** is made using a bore, positioned at the center of the input member **24** and, more specifically, centered relative to the rotation axis X, in the assembled configuration of the spring brake **15**. Furthermore, the output member **25** comprises a slug **51**, positioned in the alignment of the shaft **37**. The slug **51** of the output member **25** is therefore also centered relative to the rotation axis X, in the assembled configuration of the spring brake **15**.

Thus, the slug **51** of the output member **25** is inserted into the housing **50** of the input member **24**.

In this way, the output member **25** is centered relative to the input member **24**, using the housing **50** of the input member **24** and the slug **51** of the output member **25**.

Advantageously, the cap **33** comprises an opening **53**. Furthermore, the opening **53** of the cap **33** is a through opening. The opening **53** of the cap **33** is configured to cooperate with the shaft **37** of the output member **25**.

Thus, the shaft **37** of the output member **25** is inserted into the opening **53** of the cap **33**, so as to extend on either side of the cap **33**, in the assembled configuration of the spring brake **15**.

The input member **24** comprises the driving tooth **31**, as illustrated in FIGS. **4** and **6** to **8**. The driving tooth **31** extends between the input member **24** and the cap **33**, in the assembled configuration of the spring brake **15**.

Advantageously, the driving tooth **31** of the input member **24** is inserted inside the helical spring **22**, in the assembled configuration of the spring brake **15**.

Preferably, the input member **24** comprises a first plate **30**. Furthermore, the cap **33** comprises a second plate **32**.

Advantageously, in the assembled configuration of the spring brake **15**, the first tab **29***a* of the helical spring **22** extends along the second plate **32** of the cap **33** and the second tab **29***b* of the helical spring **22** extends along the first plate **30** of the input member **24**.

Here, the first plate **30** comprises the driving tooth **31**.

Advantageously, in the assembled configuration of the spring brake **15**, the first tab **29***a* of the helical spring **22** is configured to cooperate with a first surface **38***a* of the driving tooth **31** of the input member **24** and the second tab **29***b* of the helical spring **22** is configured to cooperate with a second surface **38***b* of the driving tooth **31** of the input member **24**. The second surface **38***b* of the driving tooth **31** is opposite the first surface **38***a* of the driving tooth **31**.

Thus, the driving tooth **31** of the input member **24** is positioned between the two tabs **29***a*, **29***b* of the helical spring **22** and is configured to cooperate with one or the other of the tabs **29***a*, **29***b* of the helical spring **22**, depending on the direction of rotation generated by the electric motor **12**, as illustrated in FIGS. **6** and **7**.

In this way, the driving tooth **31** of the input member **24** comprises two driving faces **38***a*, **38***b*. Each driving face **38***a*, **38***b* of the driving tooth **31** is configured to cooperate with one of the tabs **29***a*, **29***b* of the helical spring **22**.

Here, and as illustrated in FIGS. **4** and **5**, the helical spring **22** and the output member **25** are kept axially in position between the first plate **30** of the input member **24** and the second plate **32** of the cap **33**.

The input member **24** and, more specifically, the first plate **30** comprises a spacer **34**. The spacer **34** extends between the input member **24** and the cap **33**, in the assembled configuration of the spring brake **15**.

Thus, the spacer **34** of the input member **24** makes it possible to maintain an axial separation between the input member **24** and the cap **33** and, more specifically, between the first and second plates **30**, **32**.

Here, the spacer **34** of the input member **24** is positioned diametrically opposite the driving tooth **31** of the input member **24**, as illustrated in FIGS. **4** and **6** to **8**.

Furthermore, in this exemplary embodiment, the driving tooth **31** of the input member **24** corresponds to another spacer.

Thus, the driving tooth **31** of the input member **24** also makes it possible to maintain the axial separation between the input member **24** and the cap **33** and, more specifically, between the first and second plates **30**, **32**.

In a variant shown in FIGS. **10** and **11**, the cap **33** and, more specifically, the second plate **32** comprises the spacer **34**. The spacer **34** extends between the input member **24** and the cap **33**, in the assembled configuration of the spring brake **15**.

In such a case, the spacer **34** of the cap **33** can be positioned diametrically opposite the driving tooth **31** of the input member **24**, relative to the rotation axis X, in the assembled configuration of the spring brake **15**.

Here and as illustrated in FIGS. **4**, **5**, **8** and **9**, the first and second plates **30**, **32** each comprise a peripheral flange ring **35**, **36**. The two peripheral flange rings **35**, **36** are positioned opposite one another along the rotation axis X, in the assembled configuration of the spring brake **15**.

The input member **24** comprises a first radial retention element **54** of the helical spring **22** extending between the driving tooth **31** and the spacer **34**, along a first side C**1** of the spring brake **15**, in the assembled configuration of the spring brake **15**.

Furthermore, the cap **33** comprises a second radial retention element **55** of the helical spring **22** extending between the driving tooth **31** and the spacer **34**, along a second side C**2** of the spring brake **15**, in the assembled configuration of the spring brake **15**.

Here, the second radial retention element **55** of the cap **33** is visible in FIG. **9**.

The second side C**2** of the spring brake **15** is opposite, more specifically diametrically opposite, the first side C**1** of the spring brake **15**, relative to the rotation axis X.

Thus, the first and second radial retention elements **54**, **55** of the input member **24** and the cap **33** respectively extending between the driving tooth **31** and the spacer **34** make it possible to guarantee the radial retention of the helical spring **22** with respect to the input member **24**, the output member **25** and the cap **33**, during the manufacturing of the spring brake **15** and during the operation of the spring brake **15**, as well as to reduce the operating noises of the spring brake **15**, during the rotational driving of the input member **24** and/or the output member **25** inside the housing **26** of the drum **23**.

In this way, the first and second radial retention elements **54**, **55** of the input member **24** and the cap **33** respectively extending between the driving tooth **31** and the spacer **34** make it possible to avoid manufacturing defects related to a misalignment of the helical spring **22** with respect to the input member **24**, the output member **25** and the cap **33**.

As a result, the first and second radial retention elements **54**, **55** of the input member **24** and the cap **33** respectively extending between the driving tooth **31** and the spacer **34** make it possible to guarantee the positioning of the helical spring **22** inside the housing **26** of the drum **23**, during the assembly of the spring brake **15** and, more specifically, during a winding operation of the helical spring **22**.

Here, the first and second radial retention elements **54**, **55** of the input member **24** and the cap **33** are respectively positioned on one side C**1**, C**2** of the spring brake **15** relative to the rotation axis X and, more specifically, positioned diametrically opposite relative to the rotation axis X.

Furthermore, during the assembly of the spring brake **15**, the first and second radial retention elements **54**, **55** of the input member **24** and the cap **33** respectively extending between the driving tooth **31** and the spacer **34** make it possible to limit rubbing of the helical spring **22** on the inner friction surface **27** of the housing **26** of the drum **23** and therefore to avoid the withdrawal of at least part of a lubricant deposited on this inner friction surface **27** and on the helical spring **22**.

Furthermore, the design of such a spring brake **15** requires considering an angular travel a between one of the tabs **29***a*, **29***b* of the helical spring **22**, in the present case the second tab **29***b* of the helical spring **22**, and one of the lugs **39** of the output member **25**, in the present case a second lug **39** of the output member **25**, so as to allow the spring brake **15** to be operated, both during the release and during the activation of the spring brake **15**, as illustrated in FIG. **7**.

This angular travel a makes it possible to determine the angular dimensioning of the driving tooth **31** of the input member **24**, the spacer **34** and the lugs **39** of the output member **25**.

The first and second radial retention elements **54**, **55**, respectively of the input member **24** and the cap **33** make it possible to limit the value of the angular travel a and, as a result, to optimize the angular dimensioning of the driving tooth **31** of the input member **24**, the spacer **34** and the lugs **39** of the output member **25**, so as to guarantee the robustness thereof.

As a non-limiting example, the angular travel a can be reduced by a value in the order of 8° to 10°.

The design of such a spring brake **15** further requires taking account of the outer diameter of the output member **25**, so as to limit the operating noises of the spring brake **15**, related to the rubbing of at least one turn of the helical spring **22** against an outer surface **45** of the output member **25** and, more specifically, the lugs **39** of the output member **25**.

The first and second radial retention elements **54**, **55**, respectively of the input member **24** and the cap **33** make it possible to avoid the rubbing of at least one turn of the helical spring **22** against the outer surface **45** of the output member **25** and, as a result, to optimize the outer diameter of the output member **25**. The outer diameter of the output member **25** is defined by a circle passing through the outer surface **45** of each of the lugs **39** of the output member **25**.

The first and second radial retention elements **54**, **55**, respectively of the input member **24** and the cap **33** make it possible to guarantee the radial retention of the helical spring **22** relative to the input member **24**, the output member **25** and the cap **33**, during the manufacturing of the spring brake **15** and during the operation of the spring brake **15**.

In this way, the lubrication of the spring brake **15** and, in particular, of the contact area between the helical spring **22** and the inner surface **27** of the housing **26** of the drum **23** is improved.

Advantageously, the first side C**1** and the second side C**2** of the spring brake **15** are defined relative to the rotation axis X.

Here, the rotation axis X extends to the center of the spring brake **15** and, more specifically, between the driving tooth **31** and the spacer **34**, in the assembled configuration of the spring brake **15**.

In reference to FIG. **4**, the first side C**1** of the spring brake **15** is located to the right of the rotation axis X. Furthermore, the second side C**2** of the spring brake **15** is located to the left of the rotation axis X.

Advantageously, the first and second radial retention elements **54**, **55** respectively comprise a rib extending partially between the input member **24** and the cap **33**, along the direction of the rotation axis X, in the assembled configuration of the spring brake **15**.

Thus, the radial retention of the helical spring **15** relative to the input member **24**, the output member **25** and the cap **33** is implemented along an axial direction of the spring brake **15** and, more specifically, along the rotation axis X, so as to guarantee the alignment of the members **22**, **24**, **25**, **33** of the spring brake **15**.

Advantageously, an outer surface **46** of the first radial retention element **54** and an outer surface **47** of the second radial retention element **55** are configured to cooperate with at least one turn of the helical spring **22**.

Thus, the radial retention of the helical spring **15** with respect to the input member **24**, the output member **25** and the cap **33** is implemented by the bearing of at least one turn of the helical spring **22** against an outer surface of the input member **24** and an outer surface of the cap **33**.

Here, the radial retention of the helical spring **15** with respect to the input member **24**, the output member **25** and the cap **33** is implemented by the bearing of at least one first turn of the helical spring **22** against an outer surface of the input member **24** and by the bearing of at least one second turn of the helical spring **22** against an outer surface of the cap **33**.

Advantageously, in the assembled configuration of the spring brake **15**, the first tab **29***a* of the helical spring **22** is positioned between the first surface **38***a* of the driving tooth **31** of the input member **24** and the spacer **34**. Furthermore, the second tab **29***b* of the helical spring **22** is positioned between the second surface **38***b* of the driving tooth **31** of the input member **24** and the spacer **34**.

Advantageously, the input member **24** and the cap **33** and, more specifically, the first and second plates **30**, **32** are kept secured in rotation around the rotation axis X, in the assembled configuration of the spring brake **15**.

Here, the input member **24** and the cap **33** are fastened to one another using fastening elements **52***a*, **52***b*.

Advantageously, the fastening elements **52***a*, **52***b* of the input member **24** and the cap **33** are fastening elements by resilient snapping positioned at the driving tooth **31** and the spacer **34**.

In this exemplary embodiment, a first fastening element **52***a* of the input member **24** is arranged at the driving tooth **31** of the input member **24**. Furthermore, a second fastening element **52***a* of the input member **24** is arranged at the spacer **34** of the input member **24**.

Here, the input member **24** comprises two fastening elements **52***a* and the cap **33** comprises two fastening elements **52***b*.

In reference to FIG. **4**, only one of the fastening elements **52***b* of the cap **33** is shown.

The number of fastening elements of the input member and the cap is not limiting and can be different, in particular greater than or equal to three.

In a variant, not shown, the input member **24** and the cap **33** and, more specifically, the first and second plates **30**, **32**, can be kept secured by simple nesting.

The output member **25** is configured to be coupled to the screen **2** of the concealing device **3**.

Advantageously, the input member **24** and the output member **25** are made from plastic material.

Furthermore, the cap **33** is made from plastic material.

As a non-limiting example, the plastic material of the input member **24**, the output member **25** and the cap **33** can be polybutylene terephthalate, also called PBT, or polyacetal, also called POM.

In a variant, the output member **25** can be made from zamac (acronym for the names of its component metals: zinc, aluminum, magnesium and copper).

Preferably, the drum **23** is made from steel, in particular sintered steel.

Thus, using sintered steel to produce the drum **23** makes it possible to decrease the resistance to rubbing of the helical spring **22** against the inner friction surface **27** of the housing **26** of the drum **23**.

Owing to the present invention, the first and second radial retention elements of the input member and the cap respectively extending between the driving tooth and the spacer make it possible to guarantee the radial retention of the helical spring with respect to the input member, the output member and the cap, during the manufacturing of the spring brake and during the operation of the spring brake, as well as to reduce the operating noises of the spring brake, during the rotational driving of the input member and/or the output member inside the housing of the drum.

In this way, the first and second radial retention elements of the input member and the cap respectively extending between the driving tooth and the spacer make it possible to avoid manufacturing defects related to a misalignment of the helical spring with respect to the input member, the output member and the cap.

As a result, the first and second radial retention elements of the input member and the cap respectively extending between the driving tooth and the spacer make it possible to guarantee the positioning of the helical spring inside the housing of the drum, during the assembly of the spring brake and, more specifically, during a winding operation of the helical spring.

Furthermore, during the assembly of the spring brake, the first and second radial retention elements of the input member and the cap respectively extending between the driving tooth and the spacer make it possible to limit rubbing of the helical spring on the inner friction surface of the housing of the drum and therefore to avoid the withdrawal of at least part of a lubricant deposited on this inner friction surface and on the helical spring.

Many changes can be made to the example embodiment previously described without going beyond the scope of the invention defined by the claims.

In a variant, not shown, the electronic control unit **44** is positioned outside the casing **13** of the electromechanical actuator **11** and, in particular, mounted on the frame **20** or in the torque support **19**.

Furthermore, the considered embodiments and alternatives may be combined to generate new embodiments of the invention, without going beyond the scope of the invention defined by the claims.

The invention claimed is:

1. An electromechanical actuator for a closure or sun protection home automation installation, the electromechanical actuator comprising at least:

an electric motor;
a reduction gear; and
a spring brake,
the spring brake comprising at least:
a helical spring,
a drum that comprises a housing, the housing of the drum comprising an inner friction surface configured to cooperate with at least one turn of the helical spring,
an input member,
an output member, and
a cap,
the input member comprising a driving tooth, the driving tooth extending between the input member and the cap, in an assembled configuration of the spring brake, and
the input member or the cap comprising a spacer, the spacer extending between the input member and the cap, in the assembled configuration of the spring brake,
wherein the input member comprises a first radial retention element configured for radially retaining the helical spring,
wherein, in the assembled configuration of the spring brake, the first radial retention element extends between the driving tooth and the spacer, along a first side of the spring brake,
wherein the cap comprises a second radial retention element configured for radially retaining the helical spring,
wherein, in the assembled configuration of the spring brake, the second radial retention element extends between the driving tooth and the spacer, along a second side of the spring brake, and
wherein the second side of the spring brake is opposite the first side of the spring brake, relative to an axis of rotation of the spring brake.

2. The electromechanical actuator for a closure or sun protection home automation installation according to claim **1**, wherein the first and second radial retention elements each comprises a rib extending partially between the input member and the cap, along a direction of the rotation axis, in the assembled configuration of the spring brake.

3. The electromechanical actuator for a closure or sun protection home automation installation according to claim **1**, wherein an outer surface of the first radial retention element and an outer surface of the second radial retention element are configured to cooperate with at least one turn of the helical spring.

4. The electromechanical actuator for a closure or sun protection home automation installation according to claim **1**, wherein:
the helical spring is formed from a wire,
a first end of the helical spring forms a first tab,
a second end of the helical spring forms a second tab, and
each of the first and second tabs extends radially relative to the rotation axis and toward an inside of the helical spring.

5. The electromechanical actuator for a closure or sun protection home automation installation according to claim **4**, wherein, in the assembled configuration of the spring brake, the first tab of the helical spring is configured to cooperate with a first surface of the driving tooth of the input member and wherein the second tab of the helical spring is configured to cooperate with a second surface of the driving tooth of the input member, the second surface of the driving tooth being opposite the first surface of the driving tooth.

6. The electromechanical actuator for a closure or sun protection home automation installation according to claim **5**, wherein, in the assembled configuration of the spring brake, the first tab of the helical spring is positioned between the first surface of the driving tooth of the input member and the spacer and wherein the second tab of the helical spring is positioned between the second surface of the driving tooth of the input member and the spacer.

7. The electromechanical actuator for a closure or sun protection home automation installation according to claim **4**, wherein:
the input member comprises a first plate,
the cap comprises a second plate, and
in the assembled configuration of the spring brake, the first tab of the helical spring extends along the second plate of the cap and the second tab of the helical spring extends along the first plate of the input member.

8. The electromechanical actuator for a closure or sun protection home automation installation according to claim **1**, wherein the input member and the cap are kept secured in rotation around the rotation axis, in the assembled configuration of the spring brake.

9. The electromechanical actuator for a closure or sun protection home automation installation according to claim **8**, wherein the input member and the cap are fastened to one another using fastening elements and wherein the fastening elements of the input member and the cap are configured to fasten by resilient snapping and are positioned at the driving tooth and the spacer.

10. The electromechanical actuator for a closure or sun protection home automation installation according to claim **2**, wherein:
the helical spring is formed from a wire,
a first end of the helical spring forms a first tab,
a second end of the helical spring forms a second tab, and
each of the first and second tabs extends radially relative to the rotation axis and toward the inside of the helical spring.

11. The electromechanical actuator for a closure or sun protection home automation installation according to claim **3**, wherein:
the helical spring is formed from a wire,
a first end of the helical spring forms a first tab,
a second end of the helical spring forms a second tab, and
each of the first and second tabs extends radially relative to the rotation axis and toward an inside of the helical spring.

12. The electromechanical actuator for a closure or sun protection home automation installation according to claim **5**, wherein:
the input member comprises a first plate,
the cap comprises a second plate, and
in the assembled configuration of the spring brake, the first tab of the helical spring extends along the second plate of the cap and the second tab of the helical spring extends along the first plate of the input member.

13. The electromechanical actuator for a closure or sun protection home automation installation according to claim **6**, wherein:
the input member comprises a first plate,
the cap comprises a second plate, and
in the assembled configuration of the spring brake, the first tab of the helical spring extends along the second plate of the cap and the second tab of the helical spring extends along the first plate of the input member.

14. The electromechanical actuator for a closure or sun protection home automation installation according to claim

2, wherein the input member and the cap are kept secured in rotation around the rotation axis, in the assembled configuration of the spring brake.

15. The electromechanical actuator for a closure or sun protection home automation installation according to claim **3**, wherein the input member and the cap are kept secured in rotation around the rotation axis, in the assembled configuration of the spring brake.

16. The electromechanical actuator for a closure or sun protection home automation installation according to claim **4**, wherein the input member and the cap are kept secured in rotation around the rotation axis, in the assembled configuration of the spring brake.

17. The electromechanical actuator for a closure or sun protection home automation installation according to claim **5**, wherein the input member and the cap are kept secured in rotation around the rotation axis, in the assembled configuration of the spring brake.

18. The electromechanical actuator for a closure or sun protection home automation installation according to claim **6**, wherein the input member and the cap are kept secured in rotation around the rotation axis, in the assembled configuration of the spring brake.

19. The electromechanical actuator for a closure or sun protection home automation installation according to claim **7**, wherein the input member and the cap are kept secured in rotation around the rotation axis, in the assembled configuration of the spring brake.

20. A home automation installation for closing or providing sun protection, the home automation installation comprising:

an electromechanical actuator;

a winding tube; and

a screen,

wherein the screen is capable of being wound on the winding tube when rotated by the electromechanical actuator,

wherein the electromechanical actuator includes at least:

an electric motor;

a reduction gear; and

a spring brake,

the spring brake comprising at least:

a helical spring,

a drum that comprises a housing, the housing of the drum comprising an inner friction surface configured to cooperate with at least one turn of the helical spring,

an input member,

an output member, and

a cap,

the input member comprising a driving tooth, the driving tooth extending between the input member and the cap, in an assembled configuration of the spring brake, and

the input member or the cap comprising a spacer, the spacer extending between the input member and the cap, in the assembled configuration of the spring brake,

wherein the input member comprises a first radial retention element configured for radially retaining the helical spring,

wherein, in the assembled configuration of the spring brake, the first radial retention element extends between the driving tooth and the spacer, along a first side of the spring brake,

wherein the cap comprises a second radial retention element configured for radially retaining the helical spring,

wherein, in the assembled configuration of the spring brake, the second radial retention element extends between the driving tooth and the spacer, along a second side of the spring brake, and

wherein the second side of the spring brake is opposite the first side of the spring brake, relative to an axis of rotation of the spring brake.

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